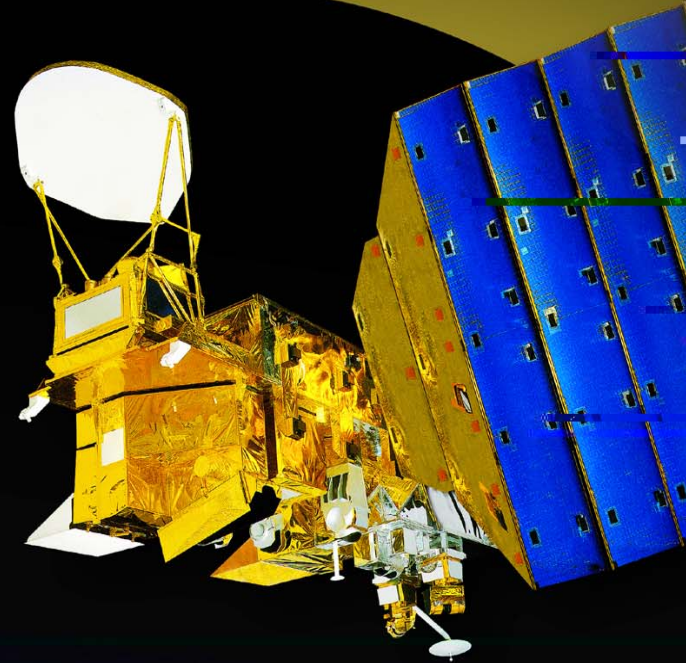


**THE ATMOSPHERIC INFRARED SOUNDER  
AIRS SCIENCE TEAM MEETING  
CALTECH – PASADENA, CA  
March 7-10, 2006**

# AIRS

**Monitoring Earth's Atmosphere**

<http://airs.jpl.nasa.gov>



**AIRS-AMSU-HSB on the NASA Aqua mission  
*both* improve operational weather prediction and  
provide Global high quality research data for  
climate studies.**



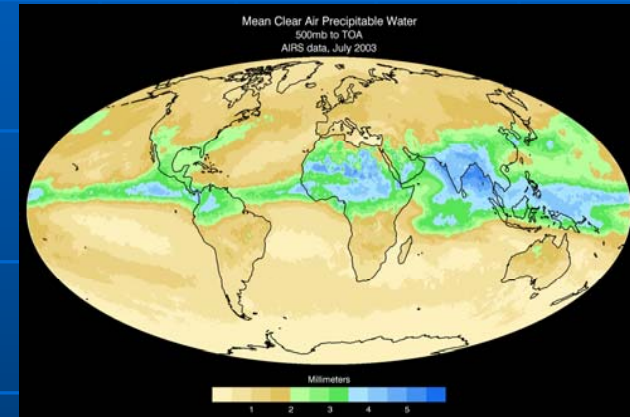
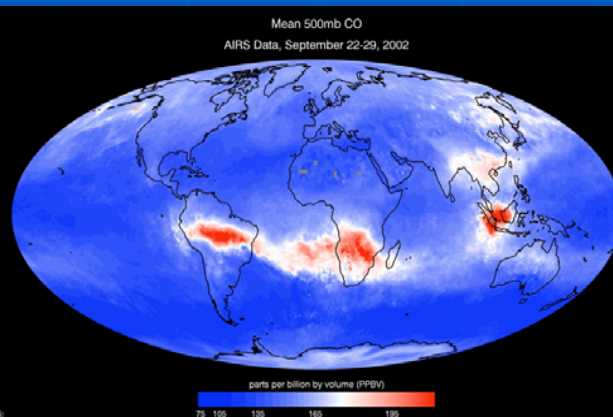
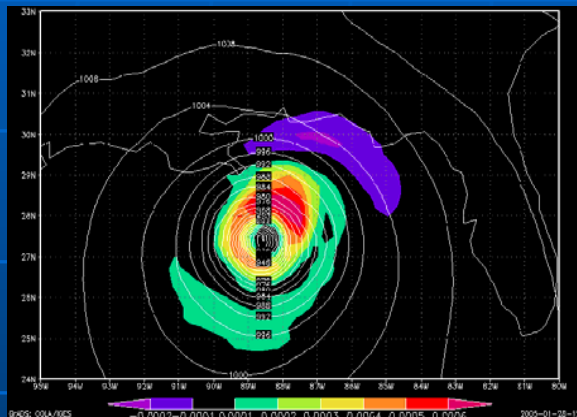
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Pasadena, California

# AIRS

Atmospheric Infrared Sounder

## AIRS/AMSU/HSB Accomplishments

*Launched May 2002 into polar orbit on Aqua, the AIRS instrument has maintained flawless operations with superb calibration accuracy and stability. Global data have been distributed to Numerical Weather Prediction Centers since September 2002. AIRS expected lifetime runs through 2009.*



### Improving Weather Prediction

AIRS achieved an improvement of 6 hours in 6 days within NOAA operational forecasts

### Tropospheric Greenhouse Gases

- CO<sub>2</sub>, CO, CH<sub>4</sub>, O<sub>3</sub>, SO<sub>2</sub>
- Global CO map published
- First global CO<sub>2</sub> map in preparation

### Hydrology Cycle

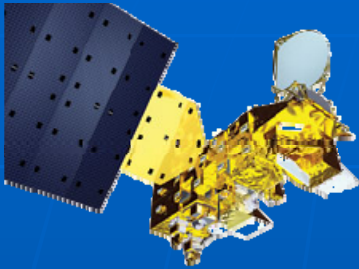
Mapping the tropospheric water vapor (Earth's primary greenhouse gas)



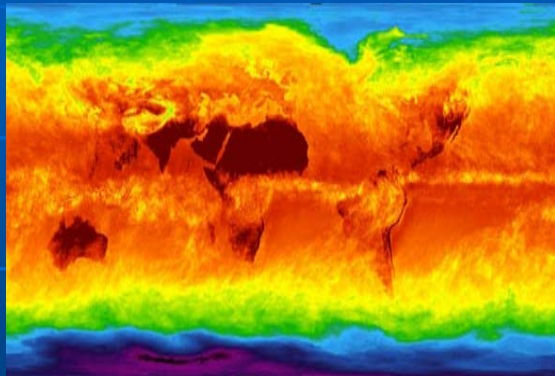
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Pasadena, California

# Infrared Radiance Spectra Can be Assimilated to Improve Weather Forecasts

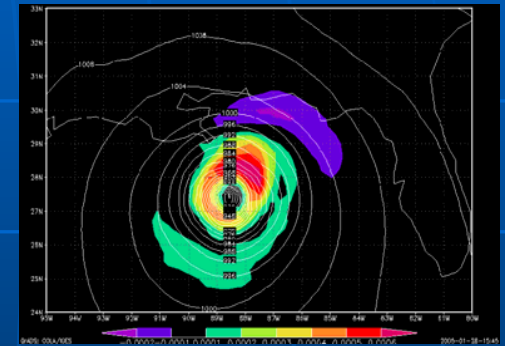
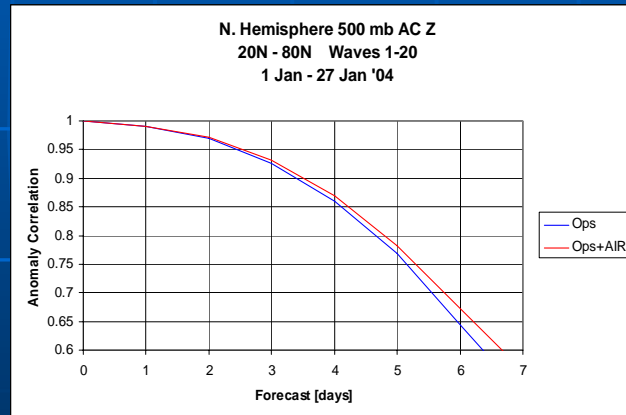


**AIRS  
on  
Aqua**



**AIRS Produces Accurate and  
Stable Radiances which are  
Assimilated by NWP Models**

**Improved Forecast Prediction  
(6 hours in 6 Days)  
Northern Hemisphere\***



**Improved Forecast of  
Hurricane Intensity and  
Tracks**

**“The forecast improvement accomplishment alone makes the AIRS project well worth the American taxpayers’ investment”**

***Said Dr. Mary Cleave, associate administrator for NASA's Science Mission Directorate***



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**From  
JSCDA  
Quarterly**

**December  
15, 2005**

## *News in This Quarter*

### **US Department of Commerce Awards Gold Medal to NOAA AIRS/AMSU Team**



*Left to right: Secretary of Commerce Carlos M. Gutierrez, Award Recipients Russ Treadon, John Derber, Larry McMillin, Fuzhong Weng, and Mitch Goldberg, NOAA Administrator Conrad Lautenbacher, and Deputy Secretary of Commerce David A. Sampson.*

The NOAA AIRS/AMSU Team – Mitch Goldberg, Fuzhong Weng, and Larry McMillin of the National Environmental Satellite, Data, and Information Service and John Derber and Russ Treadon of the National Weather Service – received the Department of Commerce's Gold Medal at a special ceremony in Washington, DC, on December 6, 2005. The Team was cited for developing techniques to assimilate advanced satellite observations into computerized models that significantly improve weather forecasting. The Team worked together on JSCDA's projects to assimilate the data from the NASA AIRS instrument and to improve the assimilation of AMSU observations over land surfaces. The Gold Medal is the Department of Commerce's highest award and recognizes distinguished performance characterized by extraordinary, notable or prestigious contributions that impact the Department's mission.

**“The Gold Medal is the Department of Commerce’s highest award and recognizes distinguished performance by extraordinary, notable or prestigious contributions that impact the Department’s mission”**



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# Atmospheric Composition Research Products Look Encouraging

## ■ Ozone

- Match TOMS to better than 5% except over ice.
- Achieved Day or Night, Globally

## ■ SO<sub>2</sub>

- AIRS distinguishes ash cloud from SO<sub>2</sub> gas

## ■ CO

- Accurate to 15% in NH
- Good Sensitivity

## ■ CH<sub>4</sub>

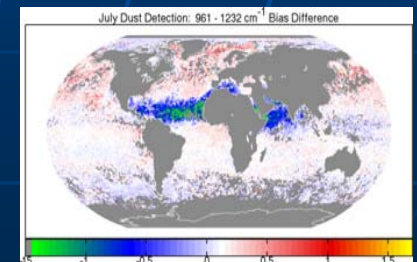
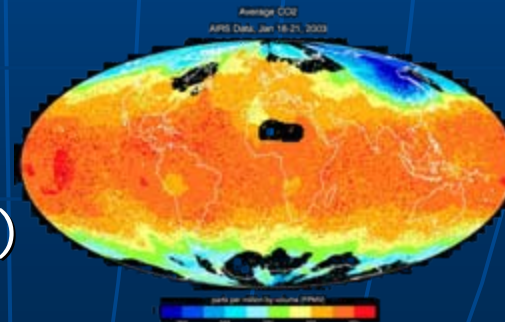
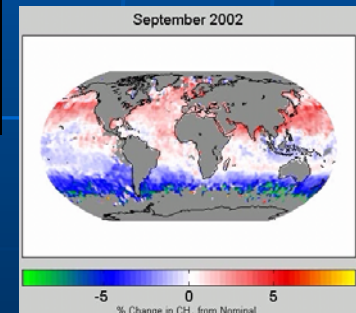
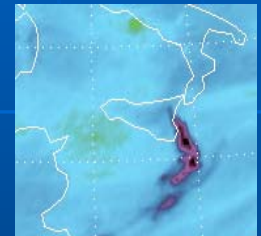
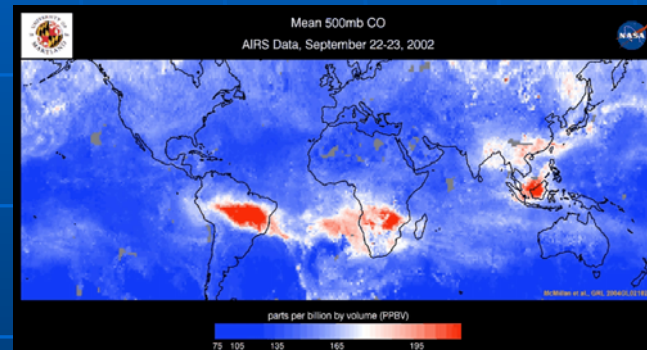
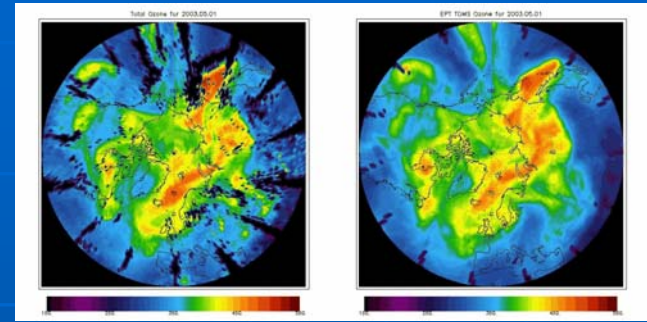
- First retrievals show expected behavior

## ■ CO<sub>2</sub>

- Accurate to 1.2 ppm
- Mid Troposphere (500 mb)

## ■ Aerosols

- Silicate signatures allow dust identification



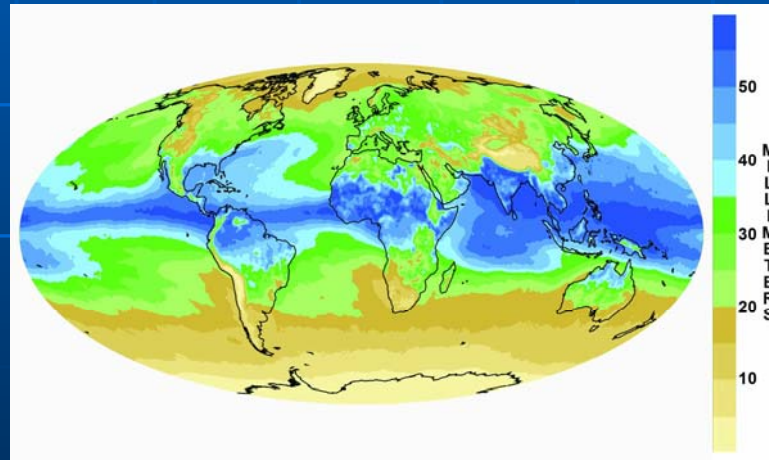
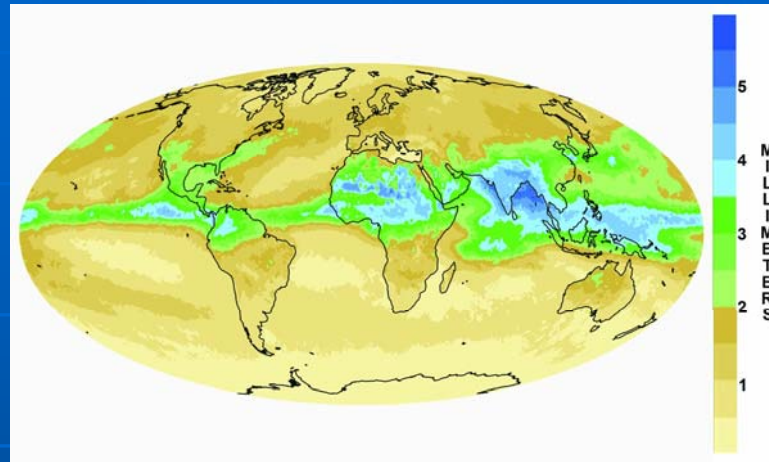


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# AIRS Water Vapor

The small fraction of ~5% of water molecules above 500hpa altitude produce about 50% the total greenhouse effect of the atmosphere.



Water vapor is the most active greenhouse gas in our atmosphere and its effect increases with altitudes where the air is significantly colder than the ground.



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# Journal Publications

120 scientific publications to date



# Publish using AIRS Data Please!

- The Scientific Literature is the best way to communicate the results of your science, build confidence in your work and record your findings for future generations
- NASA Headquarters uses publications to gauge the benefit of the missions to the science community
- AIRS has over 120 scientific publications to date (not counting instrument development or calibration)
- AIRS publications address a wide variety of science questions
- Significant science findings can become press-releases when papers are published. Good for scientists, and good for NASA



# AIRS Papers on Weather

- **J. LeMarshall**, J. Jung, J. Derber, R. Treadon, S. Lord, M. Goldberg, W. Wolf, H. Liu, J. Joiner, J. Woollen, R. Todling, R. Gelaro "Impact of Atmospheric Infrared Sounder Observations on Weather Forecasts", EOS, Transactions, American Geophysical Union, Vol. 86 No. 11, March 15, 2005
- **Goldberg, M. D.**, et al. (2003b), AIRS near-real-time products and algorithms in support of operational numerical weather prediction, IEEE Transactions on Geoscience and Remote Sensing, 41, 379.
- **Fetzer, E. J.**, et al. (2004c), Satellite remote sounding of atmospheric boundary layer temperature inversions over the subtropical eastern Pacific, Geophysical Research Letters, 31, 17102.
- **Waugh, DW** "Impact of potential vorticity intrusions on subtropical upper tropospheric humidity" JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES, 110 (D11): Art. No. D11305 JUN 4 2005
- **Goodman, S. L.**, W.; Jedlovec, G. (2004), Improving the Transition of Earth Satellite Observations from Research to Operations, in Space 2004 Conference and Exhibit, San Diego, California, Sep. 28-30, 2004., edited, San Diego, CA.
- **Chen, F. W.**, and D. H. Staelin (2003), AIRS/AMSU/HSB precipitation estimates, IEEE Transactions on Geoscience and Remote Sensing, 41, 410-417.
- **Carrier, M. J.**, et al. (2004b), Assessing the usefulness of airs radiance observations in A 4D-VAR assimilation scheme using a limited area mesoscale model and a fast radiative transfer algorithm, American Meteorological Society, Boston, MA 02108-3693, United States, Norfolk, VA, United States.
- **Chou, S.-H.**, et al. (2004b), Regional assimilation of NASA Atmospheric Infrared Sounder (AIRS) data, American Meteorological Society, Boston, MA 02108-3693, United States, Norfolk, VA, United States.
- **Fourrie, N.**, and J.-N. Thepaut (2003), Evaluation of the AIRS near-real-time channel selection for application to numerical weather prediction, Quarterly Journal of the Royal Meteorological Society, 129, 2425.
- **Frank, D.**, et al. (2002), Plans for Assimilating AQUA data at NASA's DAO, in 12th International TOVS Study Conference, edited, p. 1, FROM Australia Australia 27 Feb. - 5 Mar. 2002.
- **Frey, R.**, et al. (2003), Cloud detection from MODIS and AIRS, Optical Remote Sensing (Trends in Optics and Photonics Series Vol.85), 40-40.
- **Li, J.**, et al. (2004c), Synergistic use of MODIS and AIRS in a variational retrieval of cloud parameters, Journal of Applied Meteorology, 43, 1619.



# AIRS Papers on Trace Gas Products and Science

## ■ CO<sub>2</sub>

- **Chahine, M.**; Barnet, C.; Olsen, E. T.; Chen, L.; Maddy, E "On the determination of atmospheric minor gases by the method of vanishing partial derivatives with application to CO<sub>2</sub>". Geophys. Res. Lett., Vol. 32, No. 22, L22803 10.1029/2005GL024165.
- **Aumann, H. H.**, et al. (2005), AIRS hyper-spectral measurements for climate research: Carbon dioxide and nitrous oxide effects, Geophysical Research Letters, 32, 05806.
- **Crevoisier, C.**, et al. (2004), Midtropospheric CO<sub>2</sub> concentration retrieval from AIRS observations in the tropics, Geophysical Research Letters, 31, 17106.
- **Chedin, A.**, et al. (2003), The feasibility of monitoring CO<sub>2</sub> from high-resolution infrared sounders, J. Geophys. Res. (USA), 108, ACH6-1-ACH6-ACH6-19.
- **Engelen, R. J.**, et al. (2004), Estimating atmospheric CO<sub>2</sub> from advanced infrared satellite radiances within an operational 4D-Var data assimilation system: Methodology and first results, Journal Of Geophysical Research-Atmospheres, 109.

## ■ SO<sub>2</sub>

- **Carn, S. A.**, et al. (2005), Quantifying tropospheric volcanic emissions with AIRS: The 2002 eruption of Mt. Etna (Italy), Geophysical Research Letters, 32, 02301.
- **Wright, R.**, et al. (2005), A satellite chronology of the May-June 2003 eruption of Anatahan volcano, Journal of Volcanology and Geothermal Research, 146, 102.

## ■ CO

- **McMillan, W. W.**, et al. (2005), Daily global maps of carbon monoxide from NASA's Atmospheric Infrared Sounder, Geophysical Research Letters, 32.

## ■ CH<sub>4</sub>

- **A.Yu. Toptygin** et. al. (2005), Seasonal methane content in atmosphere of the permafrost boundary zone in Western Siberia determined from IMG/ADEOS and AIRS/AQUA data, SPIE, vol. 5655, pp. 508-514

## ■ Ozone

- **Qu, Y. N.**, et al. (2001), Ozone profile retrieval from satellite observation using high spectral resolution infrared sounding instrument, Advances In Atmospheric Sciences, 18, 959-971.

## ■ General

- **Barnet, C.**, et al. (2003), Trace gas measurements from the Atmospheric Infrared Sounder (AIRS), Optical Remote Sensing (Trends in Optics and Photonics Series Vol.85), 89-92.



# AIRS Papers on Water Vapor

## ■ Water Vapor

- **Xiouhua Fu**, Bin Wang, Li Tao, Satellite data reveal the 3-D moisture structure of Tropical Intraseasonal Oscillation and its coupling with underlying ocean, *Geophys Res. Lett.* VOL. 33, L03705, doi:10.1029/2005GL025074, 2006
- **Gettelman, A.**, E. M. Weinstock, E. J. Fetzer, F. W. Irion, A. Eldering, E. C. Richard, K. H. Rosenlof, T. L. Thompson, J. V. Pittman, C. R. Webster and R. L. Herman, 2004: Validation of satellite data in the upper troposphere and lower stratosphere with in-situ aircraft instruments. *Geophys. Res. Lett.*, vol. 31, L22107, doi:10.1029/2004GL020730.
- **Gettelman, A.**, W. D. Collins, E. J. Fetzer, A. Eldering and F. W. Irion, 2005: A satellite climatology of upper tropospheric relative humidity and implications for climate, Submitted to *J. Climate*.
- **Gettelman, A.**, E. J. Fetzer, A. Eldering and F. W. Irion, 2005, The global distribution of supersaturation in the upper troposphere from the Atmospheric Infrared Sounder, Submitted to *J. Climate*.
- **Barnes, J. E.**, and H. Voemel (2003), Water vapor measurements by raman lidar and balloon sonde at Mauna Loa Observatory, paper presented at NASD: Lidar Remote Sensing for Environmental Monitoring IV, The International Society for Optical Engineering, San Diego, CA, United States.
- **Tobin, D. C.** (2005), Validation of the Atmospheric Infrared Sounder (AIRS) over the Antarctic Plateau: Low Radiance, Low Humidity, and Thin Clouds, NTIS: Final Report, Sep 1, 2001 - Aug 31, 2004, NTIS: Performer: Wisconsin Univ. Sponsor: NASA Goddard Space Flight Center. Jan 2005. 2p.



# Papers on Clouds

## ■ Cirrus Clouds

- **Kahn, B. H., et al.** (2005), Nighttime cirrus detection using Atmospheric Infrared Sounder window channels and total column water vapor, *Journal Of Geophysical Research-Atmospheres*, 110.
- **De Souza-Machado, S., et al.** (2004b), Measurements of cirrus cloud parameters using AIRS, paper presented at NASD: Remote Sensing of Clouds and the Atmosphere VIII, International Society for Optical Engineering, Bellingham, WA 98227-0010, United States, Barcelona, Spain.

## ■ Cloud Properties

- **Li, J., et al.** (2005a), Retrieval of cloud microphysical properties from MODIS and AIRS, *Journal of Applied Meteorology*, 44, 1526.
- **Heli, W., et al.** (2004), Retrieval of semitransparent ice cloud optical thickness from atmospheric infrared sounder (AIRS) measurements, *IEEE Transactions on Geoscience and Remote Sensing*, 42, 2254-2267.
- **Wei, H., et al.** (2004), Retrieval of semitransparent ice cloud optical thickness from Atmospheric Infrared Sounder (AIRS) measurements, *IEEE Transactions on Geoscience and Remote Sensing*, 42, 2254.



# AIRS Papers on Surface Temperature, Emissivity and Climate Products

## ■ Sea Surface Temperature

- **Aumann, H. H.**, and L. Strow (2004), Sea Surface Temperature Measurements with the Atmospheric Infrared Sounder (AIRS) and Aerosol, paper presented at NASD: Remote Sensing of Clouds and the Atmosphere VIII, International Society for Optical Engineering, Bellingham, WA 98227-0010, United States, Barcelona, Spain.
- **Minnett, P.J.** (Division of Meteorology and Physical Oceanography, Rosenstiel School of Marine and Atmospheric Science, University of Miami); Maillet, K.A.; Hanafin, J.A.; Osborne, B.J. "Infrared interferometric measurements of the near-surface air temperature over the oceans" Source: Journal of Atmospheric and Oceanic Technology, v 22, n 7, July, 2005, p 1019-1032

## ■ Temperature/Emissivity

- **Knuteson, R.**, et al. (2003), Aircraft measurements for validation of AIRS land surface temperature and emissivity products at the Southern Great Plains validation site, Fourier Transform Spectroscopy (Trends in Optics and Photonics Series Vol.84), 138-138.

## ■ Climate

- **Tian, B.**, D. E. Waliser, E. Fetzer, B. Lambrigtsen, Y. Yung, and B. Wang 2005: Vertical Moist Thermodynamic Structure and Spatial-temporal Evolution of the Madden-Julian Oscillation in Atmospheric Infrared Sounder Observations. J. Atmos. Sci., Submitted
- **Aumann, H. H.**, et al. (2004b), Application of Atmospheric Infrared Sounder (AIRS) data to climate research, paper presented at NASD: Sensors, Systems, and Next-Generation Satellites VIII, International Society for Optical Engineering, Bellingham, WA 98227-0010, United States, Maspalomas, Spain.
- **Susskind, Joel** (NASA Goddard Space Flight Center) Weather and climate research with AIRS/AMSU" Source: Proceedings of SPIE - The International Society for Optical Engineering, v 5658, Applications with Weather Satellites I<sub>1,4</sub> 2005, p 166-176



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***END***